vexity, which is always posterior, is in this case much shorter in proportion. The temporal fossa, as also the surface for the muscular insertions, are extensive. The pterygoid surface is not so large as in the Suidæ. The glenoid fossa is slightly concave, but not bounded externally by a continuation of the jugal. The condyles of the mandible are nearly on a level with the molars, and the coronoid process is small and recurved. The angle is greatly modified for muscular attachment.

In the Hyracoidea, the arch is composed of three bones, of which the jugal is the most important. Resting anteriorly upon the maxilla, the jugal sends backwards a process to form the external boundary of the glenoid fossa. It also sends upwards a post-orbital process to meet a corresponding one from the parietal alone or from the parietal and frontal combined, thus completing the bony orbit. Both horizontal and vertical curvatures are slight. The surface for the temporal muscle is largely developed, while the pterygoid fossæ are well marked. The ascending ramus of the mandible is high, and the angle is rounded and projects very much behind the condyle, which last is wide transversely, and rounded on its external border. The coronoid process is small, slightly recurved, and not on a level with the condylar surface.

In the Proboscidea, the arch is straight and slender and composed of three bones. The maxilla forms the interior portion, while the jugal, supported upon the process of the maxilla, meets that of the squamosal in the middle of the arch, and is continued under this as far as the posterior root. This modification is unlike that of any other ungulate. There is a small post-orbital process from the frontal. The temporal surface is extensive, and that of the pterygoid considerable. The ascending ramus of the mandible is high, and the condyle small and round. The coronoid process is compressed, and but little elevated above the molar series. The angle is thickened and rounded posteriorly.

As has previously been remarked in regard to other orders of the Mammalia, the modifications undergone by the jugal arch in the Ungulata are determined by the development of the masticatory muscles. In the Perissodactyla, for example, the sagittal crest, ridges, and extensive parietal surface are correlated with increased insertions of the temporal muscle, while the large, strong, and complicated arch have equal reference to a powerful masseter. So in the Artiodactyla, especially in the Ruminantia, the diminished surface for the temporal, and the smaller, weaker arch, both denote diminished energy in the above muscles, while the enlarged pterygoid muscular insertions show that the required action has been provided in another direction. As Professor Cope has shown, "Forms which move the lower jaw transversely have the temporal muscles inversely as the extent of the lateral excursions of the jaw. Hence these muscles have a diminished size in such forms as the Ruminants, and are widely separated."

The singular fact that the Tylopoda alone of the selenodont Artiodactyla possess the sagittal crest is explained by Professor Cope, by the presence of canine teeth, which are used as weapons of offence and defence, and which demand large development of the temporal muscles. Moreover, this group retains the primitive form of the molar series, which is below and posterior to the vertical line of the orbit, while in the Bovidæ it is anterior.

EARLY METHODS OF BORING.

BY JOSEPH D. MCGUIRE, SMITHSONIAN INSTITUTION, WASHINGTON, D. C.

IN the process of recent investigations at the National Museum into early methods of boring as practised by different races, the writer thought that the similarity existing between the Esquimaux toggle or two-handed strap-drill, and practically the same implement used by the ancient Greeks and Hindus, and also the resemblance between the bow-drill used by the early Egyptians and the same tool used by American Indians could not fail to interest those concerned in early methods of boring.

There is an Egyptian fresco in the Royal Museum of Berlin representing a workman with a bow-drill boring a hole in the bottom of a chair, and the only difference between the drill he is using and those in the National Museum collection, especially from the Eskimo an area, is that the Egyptian bow appears much longer than the same tool used by our Indians.[1]

There is much in a comparison of these drills that is of interest regarding the evolution of the implement and the possibility of independent invention. The toggle or two-handed drill consists of a shaft a foot or more in length, a head-piece or bearing of wood or ivory, with often a stone socket for the drill-shaft to revolve in at the top. This socket-piece is held by the one working it between his teeth, and thus kept in position. The shaft is revolved by means of a narrow strap of leather wrapped once around it. On the ends of the thong are tied pieces of wood or bone by which the operator pulls the strap alternately to the right and to the left, thereby revolving the drill, which by downward pressure on the socket-piece is prevented from slipping aside.

In the ninth book of the Odessey, Ulysses describes how he and his companions, imprisoned in a cave, bored out the eye of Polyphemus (Cowper's translation.)

> "They grasping the sharp stake of olive wood,
> Infixed it in his eye, myself advanced
> To a superior stand, twirled it about.
> As a shipwright with his wimble bores
> Tough oaken timber, placed on either side
> Below, his fellow artists strain the thong
> Alternate, and the restless iron spins,
> So, grasping hard the fire-pointed stake,
> We twirl'd it in his eye; the bubbling blood
> Boil'd round about the brand."

The bow-drill used by the Zuni and other American tribes is an immense improvement on the above, for the thong is attached to a bow worked with the right hand, and the head-piece is held by the left, thus saving the jar to the head and teeth, which with the toggle drill was considerable.

[1] Lepsius, Kong'l. Museum, Abtheil. der Aegypt. Alterthümer, Berlin, 1855, tafel x.

LETTERS TO THE EDITOR.

*** *Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Confusion in Weights and Measures.

THE remarks of Professor W. P. Mason on "Confusion in Weights and Measures" in *Science* for Dec. 23, 1892, are interesting and timely. A few erroneous statements which they contain serve only to emphasize the fact that the system of weights and measures in customary use is so confusing, so unscientific, and, in some instances, apparently so contradictory that it is difficult to write of it, even briefly, without falling into error. It may be useful to the readers of *Science* to have some of these errors corrected and also to be furnished with a brief statement of the existing condition of the question of standards in the United States.

Professor Mason's difficulty in ascertaining the number of grains in a gallon of water at 60° F. is a very natural one, and one not likely to disappear in the near future. The United States gallon is a measure of capacity and not of mass. It contains 231 cubic inches. The mass of this volume of water at any given temperature can only be determined by experiment, and an accurate determination is exceedingly difficult. All results must be regarded as approximations, and variation among them means no more than variation among published values of other physical constants, which are determined by experiment, but can never be fixed by legislation. It has always been customary in the United States Office of Weights and Measures, as indeed it may be regarded as almost necessary, to adjust the volume of a capacity standard by ascertaining the mass of water which it will hold under certain conditions of temperature and pressure. But this is merely a matter of convenience; the gallon is by definition 231 cubic inches, and the bushel is 2150.42 cubic inches, and when it is desired to ascertain the mass of a gallon of water one must select that value of the density of water which one thinks the

most accurate. The latest determination of the mass of a cubic inch of water is that of Mr. H. J. Chaney, superintendent of weights and measures in London, which was communicated to the Royal Society on Feb. 4, 1890. Mr. Chaney ascertained the weight of water displaced by three bodies, which he designated respectively by the letters C, Q, and S They were: —

C, a platinized hollow bronze circular cylinder, 9 inches in diameter and height.

Q, a quartz cylinder, 3 inches in diameter and height.

S, a hollow 6 inch brass sphere.

With these he found as follows: —

In normal air a cubic inch of distilled water, freed from air, at the temperature of 62° F., was found to weigh —

C	252 267
S	252.301
Q	252.261

By normal air is meant "Air at $t = 62°$ F.; $p = 30$ inches, containing four volumes of carbonic-anhydride in every 10000 volumes of air, and also containing two-thirds of the amount of aqueous vapor contained in saturated air, weighed at Westminster, latitude 51° 29′ 53″— at 16 feet above sea-level. A cubic inch of such air weighs 0.3077 of a grain"

The International Bureau of Weights and Measures is engaged in the investigation of this constant, and when its conclusions are published the question will probably be definitely disposed of for a long time to come.

The Troughton 82-inch scale was formerly accepted as a standard of length, but for many years it has not been actually so regarded. By reason of its faulty construction it is entirely unsuitable for a standard, and for a long time it has been of historic interest only. Since its rejection as a standard the United States yard has been considered as identical with the imperial yard of Great Britain, the material representations of which are two accurate copies, made and presented to the United States at the time of the adoption of the imperial yard.

The standard of mass has been the avoirdupois pound, identical with the imperial pound of Great Britain, except for purposes of coinage, for which the standard is the Mint Troy pound, brought from London in 1827, and which was legalized for this purpose by Act of May 19, 1828, and re-enacted in the year 1873.

As, with a single notable exception to be referred to later, this is the only legislation by Congress upon the subject of standards, it is important to inquire by what authority the standards above mentioned exist as such. Professor Mason has indirectly answered this. Congress having failed to take advantage of its constitutional privilege of establishing a uniform system of weights and measures, it became necessary to provide standards for the executive departments, by means of which taxes and revenues could be determined and collected. As the Treasury Department was mostly concerned in these matters, the question of standards was left to it. To the first superintendent of the Coast Survey, Mr. Ferdinand Hassler, was committed the task of constructing standards having the necessary degree of precision, and he was made superintendent of the Office of Weights and Measures. The Troughton scale was brought to this country by him early in this century. A part of it was selected as the standard yard. In the absence of legislation, it will be seen that the standards of the United States Government were those approved as such by the secretary of the Treasury, on the recommendation of the superintendent of Weights and Measures. In the mean time, it was known that there was great lack of uniformity among the various States. To encourage such uniformity Congress, in 1836, authorized the construction of copies of the various standards used in the Treasury Department, to be distributed to the governors of the several States. This action was taken by the Office of Weights and Measures, and did much to bring about uniformity. At once many, and finally nearly all, of the States made these copies their standards, and thus practical uniformity was secured. Theoretically or rigorously, however, there are about as many systems of weights and measures in use to-day as there are States in the Union. There are cases, indeed, in which no legislation whatever has taken place, and, while there are severe penalties for the use of false measures, there is nothing to fix what measures are true, except, of course, as custom or common law controls.

The additional national legislation referred to above is the Act of 1866, by which the metric system was legalized over the whole country. This is interesting and important as being the one single bit of general statute upon the subject of weights and measures.

In 1875 the International Metric Bureau was organized. To it practically all civilized nations are now contributors. Its object was to construct and distribute prototype standards of the metre and kilogramme to the various contributing nations. These standards were completed and distributed about three years ago. The seals upon the standards for the United States, metre No. 27 and kilogramme No. 20, were broken by Benjamin Harrison, president of the United States, on Jan. 2, 1890, in the presence of James G Blaine, the Secretary of State, William Windom, the Secretary of the Treasury, and a number of gentlemen distinguished in the various professions in which precision in measurement is highly regarded.

They have thus been accepted as standards of the first authority in this country, second only to the International prototype metre and kilogramme of the International Bureau at Paris.

The metric system having thus received the recognition of the only general legislation by Congress and of executive approval, it has been determined that both the necessities of practical operations in weighing and measuring and the demands of precise metrology will be best met by referring the units of the customary system to those of the infinitely more perfect and rapidly becoming universal system based on the metre and the kilogramme. The relations of the respective units are now so accurately known that this may be done with an approximation entirely satisfactory.

Fortunately the law of 1866, in its table of equivalents, is based on these relations as then known, and later investigations have only tended to confirm the value of the yard in metres as there defined. Thus the wisest course is also the easiest, and the yard and pound, as known in the Office of Weights and Measures, are now defined as a certain part of a metre and a kilogramme, respectively.

These definitions are as follows: —

1 yard $= \frac{3600}{3937}$ metre.

1 pound $= 0.453597$ kilogramme, according to the statute of 1866.

Or more accurately —

1 English pound = 4535924277 kilogramme.

These two values differ by approximately one part in one hundred thousand. T. C. MENDENHALL

Office of Weights and Measures, Washington, D.C.

Easy Method of Calculating Complex Surveys.

A METHOD of calculation employed by Mr. L. M Graham, manager of the McLean Co. Coal Co., of this place is new to me, and may be useful, or at least interesting, to some of your readers. In the payment of royalties on coal mined, many exceedingly complicated underground surveys must be made, the computations of which are very difficult. Having made on a piece of tracing paper a plat of the survey, in all its windings, he transfers this plat to a piece of cardboard; and then cuts away the cardboard, making an opening the exact form of the plat. The cardboard containing this opening is then attached to a smooth surface as a back. As a measure, he has made in cardboard an opening one inch wide and several inches long; and down the edge of this has marked a scale; one square inch representing one hundred square feet. Taking very fine shot, he fills with this the opening in the cardboard representing the plat, taking pains to see that the shot lie but one deep; then pours these out into the measure; and readily makes his estimate. The manager says the plan was thought out by himself; and if a similar plan has been used elsewhere, he has not known of it. It strikes me as being ingenious, and widely applicable to complicated surveys, whether below or above ground. R. O. GRAHAM.

Bloomington, Ills., Jan. 25.